IMRAA.013DV1 CUSTOMER NO.: 20,995

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Jiang, et al.	) Group Art Unit 2881
Appl. No.	:	09/738,372	)
Filed	:	December 15, 2000	)
For	:	RESONANT FABRY-PEROT SEMICONDUCTOR SATURABLE ABSORBERS AND TWO PHOTON ABSORPTION POWER LIMITERS	)
Examiner	:	Jeffrey Zahn	)

ON APPEAL TO THE BOARD OF PATENT APPEALS AND INTERFERENCES APPLICANT'S BRIEF

Assistant Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

This appeal brief is filed in triplicate. A check in the amount of $750 is included to cover the fee for filing the appeal brief pursuant to 35 C.F.R. 1.17(f). Please charge any additional fees which may be required to Deposit Account No. 11-1410.

STATEMENT OF INTEREST

Pursuant to 37 C.F.R. 1.192(c)(1), Applicants hereby notify the Board of Patent Appeals and Interferences that Imra America, Inc., 1044 Woodridge Avenue, Ann Arbor, Michigan 48105, is the real party of interest.

RELATED CONCURRENT APPEAL

This application shares the identical specification as Application No. 09/738,373. In addition, the rejections being appealed are similar; they are under the same provisions and relate

to the similar issues. Clearly, decisions in either of these cases may have a bearing on the decision in the other.

REQUEST FOR CONSOLIDATED ORAL HEARING

Applicant petitions the Board of Appeals and Interferences to consolidate the appeal hearings for Application No. 09/738,372 and Application No. 09/738,373. These two cases share a specification and the rejections being appealed are similar. In addition, Applicant petitions the Board of Appeals and Interferences to consolidate these two appeal hearings with two other hearings, for Application No. 09/785944 and Application No. 09/262662. All four of these applications share a common inventor, Martin E. Fermann, and all four are assigned to the real party of interest in this case, namely Imra America. All four applications relate to lasers and methods for using lasers, and all four are pending before the same examination group and the same primary examiner, Paul Ip, in the Patent Office. Consolidating these appeals for the oral hearing will conserve the time of the Board and will reduce the cost for the Assignee.

STATUS OF THE CLAIMS AND AMENDMENTS

This application is a joint application of Jiang, Harter, Sucha and Fermann. Along with application Serial Number 09/738,373, this application is a divisional application of Serial Number 09/149,368, filed on September 8, 1998, now issued as Patent Number 6,252,892.

Claims 22-28, 33, 34 and 57-64 are pending and are the subject of this appeal.

Claims 22-28, 33, 34 and 57-64 were the subject of a final rejection mailed on June 18, 2003. An Amendment After Final Rejection was filed August 15, 2003, which amendment did not amend any of the pending claims, but included remarks and a declaration under 37 C.F.R. §1.132. An advisory action was mailed on September 11, 2003, entering the August 15, 2003 amendment, but confirming the final rejection of June 18, 2003.

SUMMARY OF THE INVENTION

The present invention is a method of achieving self-starting continuous wave ("cw") mode-locking evolving from Q-switched mode-locking (QSML). In contrast, the modelocking of most cw mode-locked lasers begins from cw noise. Modelocking is one of the most important modes of operation for a laser. When a laser is mode-locked, the optical energy is compressed into a very short pulse of about a few picoseconds. Q-switching is a means of obtaining short intense pulses from lasers. The Q-switch inhibits lasing until a very large inverted population of

excited atoms builds up. However, if the application requires a continuous wave, persistent Q-switching would be troublesome.

In addition to Q-switching, this invention may include the use of intracavity Resonant Fabry-Perot Absorbers (R-FPSA) for inducing self-starting mode-locking in a laser. An optical power limiter such as a two photon absorber (TPA)(Fig. 6, 35a), e.g., a semiconductor material, is optionally used in the laser cavity (Fig. 6, 20a) to inhibit Q-switching. The R-FPSA (Fig. 6, 37a; Fig 10, 100; Fig 11, 130) may be designed such that the nonlinear loss experienced by the saturable absorber is enhanced over the prior art Anti-resonant Fabry-Perot saturable absorber (A-FPSA) configurations. The TPA power limiter provides effective damage protection for the R-FPSA and self-adjusts the total nonlinear loss of the laser to be in the stable cw mode-locking region. The suppression of Q-switching leads to laser output that is cw modelocked.

Prior to this invention, semiconductor saturable absorbers have found application in the field of passively modelocked, ultrashort pulse lasers. These devices are attractive since they are compact, inexpensive, and can be tailored to a wide range of laser wavelengths and pulsewidths.

Prior to this invention, a method of generating cw mode-locked laser pulses with Q-switching suppression was not known. Thus, this invention is the first method of generating cw mode-locked laser pulses which generates Q-switched mode-locked laser pulses and then suppresses the Q-switching.

The R-FPSA may include two reflectors (Fig. 6, 36a, 42a) having a defined spacing. One reflector (Fig. 6, 42a) is preferably a maximum reflector that defines one end of the laser cavity (the "end reflector"), whereas the other reflector (Fig. 6, 36a) is formed by a high or partial reflector that faces the gain medium of the laser (the "inner reflector").

When the Fabry-Perot device has a defined thickness leading to a double pass phase change equaling $\delta=(2m+1)\pi$, where m is a positive integer, the Fabry-Perot structure is said to be at resonance. In this case, the fraction of the intracavity power that is reflected from the saturable absorber(R_{F-P}) is a minimum. By operating at resonance, the laser intensity absorbed by the saturable absorber is enhanced. By operating the Fabry-Perot device at resonance, the intensity absorbed by the saturable absorber is increased by a substantial factor.

The effect of varying R on $R_{F-P}(\lambda)$ for an R-FPSA is illustrated in Fig. 2 of the application. The spacing between adjacent minima is preferably large for certain applications such as ultrafast

lasers, where broad bandwidth is needed. The inner reflector should have a reflectivity R sufficiently high to provide a desired intensity on the saturable absorber. This reflectivity R, however, should not be so high that $R_{F\text{-}P}(\lambda)$ is no longer relatively flat over the gain profile. For example, if the inner reflector reflectivity R is too high, the bandwidth of $R_{F\text{-}P}(\lambda)$ at resonance needed for modelocked laser pulses may be too limited. For applications in which the spot size on the saturable absorber can not be varied (e.g., butt-coupling to a fiber or a waveguide), "tuning" the intensity on the absorber by selecting an appropriate R may be desirable.

The resonant effect on the nonlinear loss and $R_{F\text{-}P}$ as a function of wavelength is explored in Fig. 3 of the application. This Figure shows that the nonlinear loss experiences a significant enhancement when the Fabry-Perot device is designed to be at resonance. It can be seen by using the appropriate equation that the nonlinear loss at resonant (near 1540 nm) is 7 times larger than that at anti-resonance.

In one preferred embodiment, the gain medium is an erbium doped fiber (10a, Fig. 6) having an upper state lifetime on the order of milliseconds (ms), and the round trip cavity time is typically 10-100 nsec. By using an R-FPSA (37a) with a large nonlinear loss, the fiber laser may operate in a QSML regime rather than a cw modelocked regime. In this case, it may be necessary to suppress the intense Q-switched pulses, thereby driving the laser below threshold. In a preferred embodiment of this invention, a two photon absorber (TPA) (35a) is used for this purpose to complement the R-FPSA, so that the laser operates in a cw modelocked regime. The TPA preferably has little or no single photon absorption at the laser wavelength. Thus, two different types of absorbers, having different nonlinear behavior, may be used in the same device to achieve self-starting, cw modelocked behavior.

The different intensity dependencies of a preferred saturable absorber (InGaAsP) and a preferred two photon absorber (InP) are illustrated in FIG. 4 of the application. The loss due to the two photon absorber increases strongly as a function of intensity, whereas the loss due to the saturable absorber decreases (saturates) with increasing intensity. The resultant "V-shaped" total loss of FIG. 4 has a minimum which is a favorable regime for cw modelocking.

The optical limiter (e.g., the TPA) preferably has a large two photon absorption coefficient β_2, which is a function of the ratio of the material's band gap E_g and the photon energy (see, for example, E. W. Van Stryland, M. A. Woodall, H. Vanherzeele, and M. J. Soileau, "Energy band-

gap dependence of two-photon absorption," Opt. Lett., 10, 490, 1985). Fig. 5 of the application shows how the two photon coefficient scales with this ratio. For a given laser wavelength, the band gap E_g of the optical power limiter may be larger than the photon energy , so that maximum two photon absorption can be obtained without significant increase in the insertion loss, *l*. The band gap can be easily controlled by proper choice of the semiconductor material and/or its doping levels.

The TPA is effective at suppressing QSML regardless of its position in the laser cavity. For example, the TPA may adjoin the saturable absorber (Fig. 6). Alternatively, the TPA and the saturable absorber may be located on opposite sides of the gain medium (Fig. 7), or several TPAs may be used to reduce the thickness of the Fabry-Perot device, thereby offering greater design flexibility.

Fig. 9 Illustrates the evolution from Q-switched mode-locked operation (QSML) to cw mode-locked operation (CWML) as a function of time, in accordance with the invention.

Temporarily stretching of Q-switched pulses by two photon absorbers has been previously reported (see, for example, A. Hordvik, "Pulse stretching utilizing two-photon-induced light absorption", J. of Quantum Electronics, QE-6, 199 (1970) and V.A. Arsen'ev, I. N. Matveev, and N. D. Ustinov, "Nanosecond and microsecond pulse generation in solid-state lasers (review)", Sov. J. Quantum Electron, vol. 7 (11), 1321 (1978)). Also, semiconductor-based two photon absorbers have been used as optical power limiters to protect damage sensitive optics (see, for example, US patent 4,846,561 to Soileau et al.).

The band gap of a two photon absorber lies well above the photon energy at the laser wavelength, so that single photon absorption is low at low intensities. At higher intensities, however, the production rate of carriers generated from the valance band to the conduction band increases.

A two photon absorber tends to limit the pulse shortening of high intensity pulses, since pulse peaks are more strongly attenuated than the wings. Thus, the conventional understanding of the two photon absorption effect is that it degrades the performance of modelocked lasers (see, for example, A. T. Obeidat and W. H. Knox, "Effects of two-photon absorption in saturable Bragg reflectors in femtosecond solid-state lasers", OSA Technical Digest, 11, 130, Proceedings of CLEO' 97). In the high gain fiber laser disclosed herein, however, Q-switched modelocking is the

main impediment to cw modelocking. Thus, by suppressing QSML, this invention facilitates cw modelocking.

The combination of the R-FPSA and the TPA optical limiter disclosed in the application provides one arrangement for self-starting modelocking, since the R-FPSA provides quick pulse shortening due to its large saturable loss, and the optical limiter self adjusts the nonlinear loss to be within the cw modelocking stability region (FIG. 4 in the application). The TPA power limiter also provides effective damage protection for the saturable absorber. The intensity on the saturable absorber can be optimized by varying the spot size on the absorber, or by selecting R appropriately.

ISSUES PRESENTED ON APPEAL

ISSUE 1: Whether claims 22-28, 33, 34 and 57-64 omit essential steps, with such steps amounting to a gap between the steps sufficient to warrant final rejection under 35 U.S.C. 112, second paragraph.

ISSUE 2: Whether claims 22-28, 33, 34 and 57-64 are unclear in that they do not specify how a cw mode-locked laser pulse is generated with the claimed steps, or what function the steps have as related to the generation of the cw mode-locked laser pulses, such that rejection under 35 U.S.C. 112, second paragraph, is warranted.

ISSUE 3: Whether, in regard to Claim 23, it is unclear from the claim language what is being claimed, i.e. how the claimed invention is q-switched and q-switched suppressed, warranting final rejection under 35 U.S.C. 112, second paragraph.

ISSUE 4: Whether Claim 24 includes a superfluous "and", making this claim indefinite.

ISSUE 5: Whether Claims 22-24, 26-28, 33, 34, 57-59 and 61-64 are anticipated, under 35 U.S.C. 102, by Wayne et al. (US 4,176,327).

ISSUE 6: Whether Claims 25 and 60 are obvious, under 35 U.S.C. 103, in view of the combination of Wayne et al. And Hordvik (Pulse Stretching Utilizing Two-Photon-Induced Light Absorption, IEEE Journal of Quantum Electronics, April 1970).

GROUPING OF THE CLAIMS

Because of the variety of claim groupings in the section 112, 102 and 103 rejections, it does not appear that grouping the claims will make this appeal more efficient. Rather, the Applicants believe that the appeal should concentrate on the claim groupings within each of the rejections, as raised by the Examiner.

DISCUSSION OF THE REFERENCES RELIED UPON BY THE EXAMINER

WAYNE ET AL.

Wayne et al. (U.S. Patent 4,176,327) discloses a Q-switched laser which operates by altering the polarization of light reflected within the cavity. In a first state of polarization, laser action is "spoiled" by reflecting light out of the cavity (see Col. 6, ln. 8). This allows the inverted population to increase in the cavity. The polarization is then abruptly altered to cause the cavity to Q-switch (col. 6, ln. 35-48). Wayne discloses in a closing paragraph (col. 9, ln. 43052) that the laser can be mode-locked. However, there is no discussion of producing cw modelocked operation by initiating Q-switched operation, and then suppressing Q-switching. To the contrary, the mode-locked pulse is simply Q-switched to produce an output pulse. Moreover, although the Wayne et al. Cavity is "adapted for continuous wave operation" (see abstract), elements are added "to provide a high loss condition to the cavity to maintain the laser below threshold," hence to prevent cw operation. Then "a voltage applied quickly to the modulator converts the first polarization state to a second polarization state to provide a low loss condition to the cavity to Q-switch the laser". This patent is specifically directed toward Q-switched, rather than continuous wave operation.

HORDVIK

The Hordvick reference (A. Hordvick, "Pulse stretching utilizing two-photon-induced light absorption", IEEE Journal of Quantum Electronics, QE-6, No. 4 (1970)) discusses some of the experimental possibilities in utilizing a nonlinear optical material that demonstrates two-photon absorption with a Q-switch laser. The Examiner is correct that Hordvick teaches using a two-photon absorption with a laser that Q-switches. However, the article only teaches the reduction of the peak power of the Q-switch pulses, not a cw laser in which Q-switched mode-locked pulses are suppressed to yield cw mode-locked laser operation. In fact, Hordvick never mentions mode-locked or cw operation.

ARGUMENT

Issue 1: 35 U.S.C. 112 Rejection; Omission of Essential Steps; Claims 22-28, 33-34 and 57-64

The Examiner rejected Claims 22-28, 33-34 and 57-64 under 35 U.S.C. 112, paragraph 2. The Examiner found these claims to be indefinite for failing to particularly point out and

distinctly claim the subject matter which applicant regards as the invention. Specifically, the Examiner rejected the claims as being incomplete for omitting essential steps, such omission amounting to a gap between the steps (MPEP 2172.01). The Examiner identified the omitted steps as: (1) pumping a gain medium within a resonant Fabry-Perot laser cavity; (2) generating Q-switched mode-locked laser pulses using a saturable absorber located within said resonant Fabry-Perot optical cavity; (3) absorbing said Q-switched laser pulses by insertion of a Two-Photon Absorber within said resonant Fabry-Perot optical cavity; and (4) outputting a cw mode-locked laser pulse from said resonant Fabry-Perot optical cavity. The Examiner stated that these steps are essential because they (1) are necessary to generate a cw mode-locked laser pulse as disclosed by the applicant and (2) these steps are not obvious to someone of skill in the art of lasers, as related to claim interpretation, without reference to the specification.

MPEP § 2172.01 states:

> "A claim which omits matter <u>disclosed to be essential to the invention as described in the specification, or in other statements of record</u> may be rejected under 35 U.S.C. 112, first paragraph, as not enabling. *In re Mayhew,* 527 F.2d 1229, 188 USPQ 356 (CCPA 1976). See also MPEP 2164.08(c). Such essential matter may include missing elements, steps or necessary structural cooperative relationships of elements <u>described by the applicant(s) as necessary to practice the invention.</u>
>
> "In <u>addition</u>, a claim which fails to interrelate <u>essential elements of the invention as defined by applicant(s) in the specification</u> may be rejected under 35 U.S.C. 112, second paragraph , for failure to point out and distinctly claim the invention See *In re Venezia,* 530 F.2d 956, 189 USPQ 149 (CCPA 1976); *In re Collier*, 397 F.2d 1003, 158 USPQ 266 (CCPA 1968)." **(Emphasis added.)**

Under the language of MPEP 2172.01, as emphasized above, the applicant is only obliged to claim elements that were defined to be essential in the specification or in other statements of record. Applicants did not disclose in the specification, or in any other statement of record, that these steps were "essential." In *Mayhew*, the court ruled one step to be essential. There the court pointed to specific language of importance. "Appellant's specification states that the 'strip...and bath...are raised in temperature above what is ordinarily considered optimum coating temperatures. <u>This is practicable because of special cooling apparatus, specially located.</u>'" *Mayhew*, 527 F.2d at 1233. The above language of the application in that case made it clear that the element was essential to the invention. In the present application, there was no such language regarding any of the elements the Examiner regards as omitted essential elements. It is

noteworthy that a second group of claims in the *Mayhew* patent were also rejected because of omission of an essential element, namely the specific temperature and functions of the cooling zone. The *Mayhew* court overturned this second rejection of claims. The court reasoned that a person of ordinary skill in the art could determine the appropriate temperature and functions for the cooling zone based on the specification and particular uses with the patented process. *Mayhew,* 527 F.2d at 1233-1234.

A similar rationale should be applied to this application. The overarching essential steps are those steps that a person of ordinary skill would not do. Here, those steps are the suppression of Q-switching to generate cw mode-locked laser pulses. That is the new step that was introduced by these inventors, and that is what is claimed by the application. The alleged omitted essential steps are steps that anyone of ordinary skill in the art would recognize. First, those of ordinary skill would know that many lasers have a gain medium in the laser cavity which is pumped to create an inverted population, and would know how to build the same. The next two "omitted" elements go to the generation and suppression of Q-switching. Q-switching is a topic that has been covered thoroughly in both scholarly work and patents, and the generation of Q-switched laser pulses is something that a person of ordinary skill could accomplish in a number of ways. See, for example, Kajava, et. al. Q-switching of a diode-pumped Nd:YaG laser with GaAs, *Optics Letters*, Vol. 21, No. 16, August 15, 1996, pgs. 1244-1246; Everett, Laser mode-locking, Q-switching and dumping system, Patent number 4,375,684 (1983); and the two references, Wayne et al. And Hordvick, which form the basis for rejections in this application.. The suppression of Q-switching is taught by one of the references the Examiner cites, the Hordvick reference (see, for example, the first column on page 201, in the sentence immediately preceding the heading "Experiment"). While there may be several other ways to accomplish this task, the fact that one of these methods is clearly described in the cited prior art verifies that suppression of Q-switching was known to persons of ordinary skill in the art. Finally, the Examiner argues that "outputting a cw mode-locked laser pulse from said resonant Fabry-Perot optical cavity" is another omitted essential element. Output of a laser pulse from within the optical cavity, once such a pulse is generated, is a topic that is surely understood by anybody of ordinary skill in the field. See, for example, Ichinose, et. al., High power multibeam laser, Patent number 3,943,461 (1976). All of these "essential" elements are steps that are known to persons

of ordinary skill in the art and are possible features of the invention claimed here, but they are not essential to the invention. In sum, the "essential" elements that were used to reject claims are comparable to the temperature and function rejections in *In re Mayhew*, and like those rejections, should be withdrawn.

In addition, the long-term viability of the *In re Mayhew* decision's "essential elements" ground is not clear. The case is rarely cited for this principle, and the cases on which the majority relies do not clearly support the decision. The majority cites only five cases, all of which overturn at least some of the original §112 indefiniteness rejections. *In re Borkowski*, 422 F.2d 904, 164 USPQ 642 (1970); *In re Moore*, 439 F.2d 1232, 169 U.S.P.Q. 236 (1971); *In re Sarett*, 327 F.2d 1005, 140 U.S.P.Q. 474 (1964); *In re Corr*, 347 F.2d 578, 146 U.S.P.Q. 69 (1965); *In re Honn*, 364 F.2d 454, 150 U.S.P.Q. 652 (1966). In *Moore,* the court explained how a claim must be interpreted for definiteness:

> "This first inquiry therefore is merely to determine whether the claims do, in fact, set out and circumscribe a particular area with a reasonable degree of precision and particularity. It is here where the definiteness of the language employed must be analyzed - not in a vacuum, but always in light of the teachings of the prior art and of the particular application disclosure as it would be interpreted by one possessing the ordinary level of skill in the pertinent art." *Moore,* 439 F.2d at 1235.

This test does not clearly support the rule in *Mayhew*, as applied by the Examiner. Indeed, *Mayhew* seems to decide the case on a rule that the precedents cited do not clearly support.

In *Microsoft v Reiffin,* 214 F.3d 1342; 54 U.S.P.Q.2d (BNA) 1915, the Federal Circuit panel avoided the question of whether there is such an "essential element" test and decided the case on other grounds. See also, Donald S. Chisum, 6 Chisum on Patents § 7.04[2] (2001). However, in concurrence, Judge Newman felt that the question was ripe in the case and that the validity of the "omitted element" test was questionable. As Judge Newman stated:

> "The district court accepted Microsoft's proposition that the patentee must include in every claim "each and every element" that was described as "part of his invention," whether or not the element is necessary for patentability of the claim. Failure to do so, the district court held, invalidates the claims for noncompliance with the written description requirement of § 112 P[aragraph] 1. That is not a correct statement of the law. Section 112 P[aragraph]2 instructs the applicant to "distinctly claim[] the subject matter which the applicant regards as his invention." This does not automatically require inclusion in every claim of every element that is part of the device or its operation." *Microsoft*, 214 F.3d at 1347.

The "omitted element" test is based on questionable precedents and unclear decisions. Other cases that have been used to support the test do not really go to the question of whether every element of an invention needs to be claimed. For example, Microsoft cited *Gentry Gallery, Inc. v. Berkline Corp.*, 134 F.3d 1473, 45 U.S.P.Q.2d (BNA) 1498 (Fed. Cir. 1998) in order to support their contention that all elements of an invention need to be claimed. *Microsoft*, 214 F.3d at 1347 (Newman, J. concurring.). However, this case merely states the oft-stated proposition that claims that are broader than the application's disclosure will not be allowed. *Id.* And, finally, cases have stated the proposition that there is, at least with respect to combination patents, no "essential" element. *Aro Mfg. Co. v. Convertible Top Replacement Co.*, 365 U.S. 336, 345, 128 U.S.P.Q. (BNA) 354 (1961) ("[T]here is no legally recognizable or protected "essential" element, "gist" or "heart" of the invention in a combination patent.")

In addition to the fact that the validity of the "omitted" or "essential" element test is in doubt, this application does not even meet the test. The application discloses more than enough information to allow one of ordinary skill in the art to practice the invention, and the claims at issue here define the invention in terms well understood by those of ordinary skill in this art. Most importantly, the "missing elements" identified here are all routine elements which are well understood by persons of ordinary skill in this art to be variants which are routinely included in lasers.

In his rejection, the Examiner argues that :

> The determination of "essential elements" required to be claimed to support the enablement of claims and to adequately describe the metes and bounds of the invention to one of ordinary skill in the art is not a subjective test on the applicant. The standard is what "one of ordinary skill in the art" would have understood to be essential elements.

The Applicants have submitted with this Amendment a declaration from Jerry W. Kuper. Dr. Kuper is a person skilled in the field of lasers and laser systems who has worked in the field of laser design and development for more than 20 years. Moreover, Dr. Kuper has supervised scientists working in the field through this 20 year period, and is thus particularly knowledgeable regarding the background and knowledge of persons of ordinary skill in the art to which this invention pertains, as of the effective filing date of this application. In this regard, Dr. Kuper declares:

E) By ordinary skill, I mean scientists who are capable of understanding lasers and laser systems, and who are capable of designing such systems for specific applications, using known techniques and devices. These are scientists who know the vocabulary related to lasers, and are capable of reading descriptions of known techniques and devices in this field in order to implement known technology.

Moreover, Dr. Kuper has no financial interest in this application. He is an independent expert.

In regard to the "essential elements" rejection, and the Examiner's statement that the standard is "what 'one of ordinary skill in the art' would have understood to be essential elements, Dr. Kuper states:

K) Persons of ordinary skill in the laser art, as of the effective filing date of this application, would understand the words used in Claims 22-28, 33, 34 and 57-64.

1) Persons of ordinary skill in the laser art, as of the effective filing date of this application, would have understood the term "CW mode-locked laser pulses", because this term was commonly used and well defined in the art at the time. This term was understood to mean pulses output from a mode-locked laser cavity at each circulation of mode-locked light within the cavity, in the form of a continuous pulse series.

2) Persons of ordinary skill in the laser art, as of the effective filing date of this application, would have understood not only what "Q-switched mode-locked laser pulses" are, but would have known how to generate such pulses. In fact, as of that date, knowledge of Q-switched mode-locked laser pulses and their generation was common in this field. See, for example, the Hordvik publication which has been cited in this case by the Examiner.

3) Persons of ordinary skill in the laser art, as of the effective filing date of this application, would understand not only what "suppressing Q-switching" means, but would understand the ways in which such suppression could be accomplished. See, for example, the Hordvik publication which has been cited in this case by the Examiner.

M&N) From the description provided in the specification of the pending application, persons of ordinary skill in the laser art would be able to design and build a laser system which operates according to the methods defined in Claims 22-28, 33, 34 and 57-64. More specifically, with regard to Claim 22, persons of ordinary skill in the laser art would be able to generate Q-switched mode-locked laser pulses, and would be able to suppress Q switching to generate cw mode-locked pulses.

O) The steps identified on page 2 of the rejection of the application mailed on 6/18/2003 are all well known to someone of skill in the art of lasers, even without the benefit of the specification of this application. Thus, (1)pumping a gain medium within a resonant Fabry-Perot laser cavity; (2) generating Q-switched mode-locked laser pulses using a saturable absorber located within said resonant Fabry-Perot optical cavity; (3) absorbing Q-switched laser pulses by insertion of a Two-Photon Absorber within a resonant Fabry-Perot optical cavity, and (4) outputting a mode-locked laser pulse from a Fabry-Perot optical cavity were all well known steps as of the effective filing date of this application. However, the generation or evolution of CW mode-locked laser pulses by suppressing Q-switching, to the best of my knowledge, was not known at that time.

Issue 2: 35 U.S.C. 112 Rejection; Clarity of Claims 22-28, 33, 34 and 57-64

The Examiner states that it is unclear from the claim language how a cw mode-locked laser pulse is generated with the claimed steps. Specifically, the Examiner states that it is not clear what function the steps have as related to the generation of the cw mode-locked laser pulses.

The specification provides a clear description of how cw mode-locked laser pulses are generated using this invention. Claims are not required to provide every detail for implementing an invention, but only the necessary elements of the inventive process, because the steps cited by the Examiner are well known variants to those skilled in the art. To require the Applicants to limit their claims to a particular selection of alternative incidental steps would deny them of the breadth of protection which the law requires.

This rejection under 35 U.S.C. 112 appears to derive from a basic misunderstanding of the term "cw mode-locked laser pulses" used in the claims. In the final rejection, the Examiner states:

> The Applicant makes the argument that the claims "...are not required to define every detail of their laser in their claims and in particular are not required to define the details which do not form a part of their invention. (Page 6)
>
> This argument is not persuasive because it is not clear from the claims what the Applicant is claiming. <u>The characteristics of a CW laser and a pulse laser are different. Someone of ordinary skill in the art recognizes a CW laser as generating a sinusoidal type pattern of laser energy continuously; conversely, a pulse laser is characterized as having an output that has a definite beginning and end.</u> The Applicant claims "CW mode-locked laser pulses" without the necessary method steps within the claims to establish a CW mode-locked laser pulses. (emphasis added)

Applicants believe that paragraphs K and S from the declaration of Dr. Kuper point out the Examiner's misunderstanding:

> K) Persons of ordinary skill in the laser art, as of the effective filing date of this application, would understand the words used in Claims 22-28, 33, 34 and 57-64.
>
> > 1) Persons of ordinary skill in the laser art, as of the effective filing date of this application, would have understood the term "CW mode-locked laser pulses", because this term was commonly used and well defined in the art at the time. This term was understood to mean pulses output from a mode-locked laser cavity at each circulation of mode-locked light within the cavity, in the form of a continuous pulse series.
> >
> > .....
>
> S) The following statement at page 6 of the rejection of the application mailed on 6/18/2003 is incorrect in the context of this application: "The characteristics of a CW laser and a pulse laser are different. Someone of ordinary skill in the art recognizes a CW laser as generating a sinusoidal type pattern of laser energy continuously; conversely, a pulse laser is characterized as having an output that has a definite beginning and end". In fact, mode-locked lasers produce pulse outputs and were commonly operated in a CW mode as of the effective filing date of this application. Such lasers, as stated above, produce an output pulse at each circulation of mode-locked light within the cavity, thus forming a continuous pulse series.

Because the Examiner's rejection was based on a misunderstanding of the well known terms used in the claims, and because a person of ordinary skill in this art would have a clear understanding of the subject matter defined in the claims, this rejection should be reversed.

Issue 3: 35 U.S.C. 112 Rejection; Clarity of Claims; Claim 23.

The Examiner states that Claim 23 does not specify how the invention is Q-switched and Q-switched suppressed. As noted above, techniques for Q-switching are well known in this art. The claim itself states that in at least one embodiment, Q-switching is suppressed by absorbing the Q-switched pulses. This rejection should be reversed.

Issue 4: 35 U.S.C. 112 Rejection; Clarity of Claims; Claim 24

The ending word "and" was removed, as requested by the Examiner, in an amendment filed April 4, 2003.

Issue 5: 35 U.S.C. 102 Rejection; Claims 22-24, 26-28, 33, 3457-59 and 61 to 64

The examiner rejected claims 22-24, 26-28, 33, 3457-59 and 61 to 64 as anticipated by Wayne. The Examiner states that Wayne discloses a method of generating laser pulses comprising generating Q-switched mode-locked laser pulses (col. 4, line 66- col. 5, line 27; abstract) and suppressing q-switching (col. 6, lines 28-50; abstract). The Examiner also states that the method disclosed by Wayne is a "method of generating laser pulses in a continuous wave mode-locked fashion (abstract). The Examiner states, however, that this limitation "A cw mode-locked laser" is not given patentable weight because "the body of the claim does not support a cw mode-locked laser pulse, i.e., there is no claimed step to manipulate any structural feature of the invention to generate a cw mode-locked laser pulse." In previous rejections, The Examiner has based this refusal on *In re Hirao*, 535 F.2d 67, 190 USPQ. 15 (CCPA 1976) and *Kropa v Robie*, 187 F.2d 150, 88 USPQ. 478 (CCPA 1951). However, these cases are neither clear nor determinative. In fact, *Kropa* has been read by the Federal Circuit to underscore the importance of the claim preamble.

> "If the claim preamble, when read in the context of the entire claim, recites limitations of the claim, or, if the claim preamble is `necessary to give life, meaning, and vitality' to the claim, then the claim preamble should be construed as if in the balance of the claim. ... Indeed, when discussing the `claim' in such a circumstance, there is no meaningful distinction to be drawn between the claim preamble and the rest of the claim, for only together do they comprise the `claim'." *Pitney Bowes, Inc v. Hewlett-Packard Co*, 182 F.3d 1298, 1305, 51 U.S.P.Q.2d 1161, 1165-66 (Fed. Cir. 1999) citing *Kropa*, 187 F.2d at 152, 88 USPQ at 480-81.

Other cases have pointed out that the claim preamble should be considered when evaluating obviousness over a prior art reference. *In re Stencel,* 828 F.2d 751, 4 U.S.P.Q.2d 1071 (Fed. Cir. 1987); *In re Duva,* 387 F.2d 402, 407, 156 U.S.P.Q. 90 (CCPA 1967); *In re Walles,* 366 F.2d 786, 790, 151 U.S.P.Q. 185 (CCPA 1966). A similar type of patent claim was at issue in *Wales*. There, the preamble in question said, "A composition for setting hair comprising a ring substituted N-vinyl-z-oxazolidinone polymer of the structural formula:" *Walles*, 366 F.2d at 788. The examiner in that case argued that the words "for setting hair," carried no patentable weight. However, the Court of Claims and Patent Appeals rejected this argument.

> [W]e do not agree that the portion of the patent claims which recite "a composition for setting hair," may be ignored in determining what invention is defined by the patent claims. An examination of the patent specification, including the objects of the invention, the discussion of the prior art, and the examples set forth, reveals that it is directed solely to compositions for setting hair. The only interpretation of the patent claims consistent with the disclosure is that the invention, the subject matter claimed therein, is a hair setting composition. *Walles*, 366 F.2d at 716-17.

Throughout the application on appeal here, the invention is referred to as a cw mode-locked laser. In the field of invention statement, the invention is related "generally to modelocking, and in particular, to cw mode-locking...". Application at page 1, line 1-2. In the Description of the Related Art section of the application, saturable absorbers are discussed within the context of being modelocking elements. See, for example, application at page 2, line 14. In the Drawings, an emphasis is placed on cw mode-locking. See, for example, Fig. 11. In the Detailed Description of the Preferred Embodiment section, the invention is clearly defined as relating to cw mode-locked lasers through statements like, "In several preferred embodiments of this invention, self-starting cw mode-locking is obtained from Q-switched mode-locking." Application at page 10, line 31-32. The fact that this invention relates to cw mode-locked lasers is obvious from the application. To read the claims giving no patentable weight to the "cw mode-locked laser" language in the preamble is to read the claims with no regard to the specification or any of the rest of the application. Clearly, this is not proper claim interpretation. *Walles*, 366 F.2d at 790. ("We do not agree that the patent claims before us can be interpreted [without looking at the claim preamble in light of the facts of the application] ... nor is such a method of analysis proper in determining whether two sets of claims are 'patentably indistinct.'")

In this application, the claim preamble is "necessary to give life, meaning, and vitality" to the claim. The preamble is more than a mere intended use; it is a limitation on the claims. The effect of these words distinguishes the invention from the prior art and limits the claims. If the claims are read in the context of the entire patent application, it is clear that the preamble language is meant to limit the claims. In addition, the fact that these words appear in the preamble as compared to the body of the claim is really a matter of little import.

Note that claims 57 through 64 were added to this application to correct this issue; the language "to yield cw mode-locked pulses" is simply added within the body of these claims.

However, the risk and potential cost of this change could be high given the unclear state of prosecution history estoppel law. See *Festo Corp. v. Shoketsu Kinzoku Kogyo Kabushiki Co.*, 122 S. Ct. 1831 (2002). Considering that the language was already in the claim, this is a risk that the applicant should not face. The preamble language must be given patentable weight and should be used to define the invention for obviousness purposes.

As to the anticipation rejection itself, by its own terms, the Wayne reference teaches a Q-switched laser which is cavity dumped, not a cw mode-locked laser. Nowhere does Wayne teach or suggest a cw mode-locked laser. The only mention of CW is in the abstract, where Wayne describes the basic type of laser used as his starting point. He then immediately states what he does with this laser...he converts polarization states to Q-switch the laser, then terminates the voltage near the maximum Q-switch buildup to convert the polarization to cavity dump an output pulse. Simply stated, this is not a cw mode-locked laser, and it does not produce cw mode-locked laser pulses. Moreover, the Wayne patent never states that it produces cw mode-locked laser pulses. Nor does the Wayne patent teach the suppression of Q-switching to produce cw mode-locked pulses. Rather, Wayne teaches cavity dumping at the peak of the intracavity Q-switch buildup (col. 6, ln. 41-43) to dump the cavity to provide an optical pulse. Even in the alternative mode-locked version mentioned at Col. 9, lines 39 to 52, Wayne develops mode locked energy in the cavity, resulting in a Q-switch buildup, where the Q-switched envelope is modelocked. The cavity is then dumped when the recirculating pulse is at its peak amplitude, resulting in a single short pulse. This is the antithesis of cw mode-locking.

Again, reference to the statements in Dr. Kuper's declaration are helpful, since they provide further evidence to bolster the argument above:

> L) Notwithstanding the fact that "CW mode-locked laser pulses" were well understood at the effective filing date of this application, and that Q-switching and its suppression were also well known in this field as of the effective filing date of this application, I am not aware of any knowledge in this field, as of that effective date, that CW mode-locked laser pulses could be evolved or generated from the suppression of Q-switching.
>
> P) Wayne et al. (US 4176327) does not disclose the generation of CW mode-locked laser pulses. Rather, by its own terms, the Wayne laser is cavity dumped. A cavity dumped laser was well known as of the effective filing date of this application as a laser in which the energy within the cavity is allowed to build up until a switched

phenomenon dumps the energy to the cavity output. This is not a CW mode-locked laser, and does not produce CW mode-locked pulses. The mention of CW in the Wayne abstract describes only the basic type of laser used as his starting point, which Wayne converts to a Q-switched laser for his experiment.

Q) While the Wayne patent states in his Claim 1 that his laser energizes "the gain medium to obtain a population inversion therein capable of providing continuous wave radiation oscillating with the laser", Wayne does not produce a CW output, as stated above. Rather, Wayne cavity dumps the laser to concentrate as much power as possible in a single pulse. This is, effectively, the opposite of CW mode-locked laser pulses.

Applicants request a reconsideration of the anticipation rejection in view of the fact, as evidenced by the Kuper declaration, that Wayne does not anticipate these claims.

Issue 6: 35 U.S.C. 103 Rejection; Claims 25 and 60

The examiner rejected Claims 25 and 60 as obvious over Wayne in view of Hordvik. As stated above, Wayne does not meet the essential limitations of the parent claims as suggested by the Examiner. Hordvik does not correct this fundamental void in the cited art. Rather, Hordvick teaches only a Q-switched laser with stretched pulses, not a laser in which cw mode-locked energy is generated from Q-switched mode-locked pulses. The most that Hordvick could add to Wayne's disclosure is the stretching of pulses, not the generation of cw mode-locked pulses. This fact is confirmed by Dr. Kuper in his declaration:

R) The Hordvik article, identified above, only teaches a Q-switched laser with stretched pulses, not a CW mode-locked laser.

Applicants continue to believe that the rejections in the case should be withdrawn, particularly in view of the additional evidence presented in the form of the declaration of Dr. Kuper

<u>REQUEST FOR ORAL HEARING</u>

Applicant hereby requests an Oral Hearing in this Appeal.

CONCLUSION

Applicants submit that the claims of this application are allowable and that the rejections should be overruled by the Board of Appeals.

Respectfully submitted,

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Dated: 1/15/04

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APPENDIX

CLAIMS ON APPEAL

1-21, Cancelled

22. (Original) A method of generating cw mode-locked laser pulses, comprising:

generating Q-switched mode-locked laser pulses; and

suppressing Q-switching.

23. (Original) A method as defined in Claim 22, wherein said suppressing step comprises absorbing Q-switched laser pulses.

24. (Original) A method as defined in Claim 23, wherein said absorbing step absorbs a fraction of the Q-switched pulses.

25. (Original) A method as defined in Claim 23, wherein said absorbing step comprises two photon absorption.

26. (Original) A method as defined in Claim 22, wherein said generating step comprises:

pumping a gain medium located within a laser cavity; and

absorbing optical radiation from said gain medium in a Fabry-Perot structure.

27. (Previously Amended) A method as defined in Claim 26, wherein said generating step additionally comprises resonating said optical radiation within said Fabry-Perot structure.

28. (Original) A method of generating cw mode-locked laser energy, comprising:

evolving cw modelocking from Q-switched modelocking.

29-32, Cancelled

33. (Original) A method of generating cw mode-locked laser pulses, comprising:

generating Q-switched mode-locked laser pulses; and

preferentially suppressing Q-switching without suppressing cw mode-locked laser pulses.

34. (Previously Amended) A method of generating cw mode-locked laser energy, comprising:

generating Q-switched mode-locked pulses.

35-56, Cancelled

57. (Previously presented) A method of generating cw mode-locked laser pulses, comprising:

generating Q-switched mode-locked laser pulses; and

suppressing Q-switching to yield cw mode-locked pulses.

58. (Previously presented) A method as defined in Claim 57, wherein said suppressing step comprises absorbing Q-switched laser pulses.

59. (Previously presented) A method as defined in Claim 58, wherein said absorbing step absorbs a fraction of the Q-switched pulses.

60. (Previously presented) A method as defined in Claim 58, wherein said absorbing step comprises two photon absorption.

61. (Previously presented) A method as defined in Claim 57, wherein said generating step comprises:

pumping a gain medium located within a laser cavity; and

absorbing optical radiation from said gain medium in a Fabry-Perot structure.

62. (Previously presented) A method as defined in Claim 61, wherein said generating step additionally comprises resonating said optical radiation within said Fabry-Perot structure.

63. (Previously presented) A method of generating cw mode-locked laser pulses, comprising:

generating Q-switched mode-locked laser pulses; and

preferentially suppressing Q-switching without suppressing cw mode-locked laser pulses to yield cw mode-locked laser pulses.

64. (Previously presented) A method of generating cw mode-locked laser energy, comprising:

generating Q-switched mode-locked pulses to yield cw mode-locked laser pulses.